

position changed to the side; large quantities of gas discharged by this means.

*Nov. 21.*—To-day bowels were moved for the first time by a glycerine and ox gall enema. An enormous evacuation, completely filling the bed pan, was the result.

*Nov. 23.*—For two days has been sitting up a little in bed. The bowels have been moved each day by enemata, and the diet has been increased by the addition of farinaceous food and milk, with raw oysters and champagne.

*Nov. 24.*—The patient complained of severe pain in the back, yawning and wandering pains in the limbs, followed by slight fever. These symptoms were succeeded by a chill on the next morning, and yielded in a few days to quinine. With this exception the patient's further progress to recovery was uninterrupted. The stitches were removed Nov. 25. the wound having healed under one dressing.

So far as I can learn, this is the first successful case of laparotomy for acute intestinal obstruction in this city.

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AN EXPERIMENTAL CONTRIBUTION TO INTESTINAL SURGERY WITH SPECIAL REFERENCE TO THE TREATMENT OF INTESTINAL OBSTRUCTION.<sup>1</sup>  
(CONTINUED.)

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II.—ENTERECTOMY.

IT still remains an open question to what extent resection of the small intestines can be performed with impunity. It is true that Koeberlé, Kocher and Baum, have successfully removed respectively 2.05m., 160ctm., and 137 ctm. of the small

<sup>1</sup>Read in the Surgical Section of the Ninth International Medical Congress, Washington, September 5.

intestine in the human subject, but while two of the patients do not appear to have suffered any ill effects in consequence of the removal of such a large surface for digestion and absorption, in Baum's case death, which supervened six months after the operation, was attributable clearly to marasmus, brought about by the extensive intestinal resection. As in a number of pathological conditions of the intestinal canal, as multiple strictures, gangrene, and multiple gunshot wounds, where the wounds are large and in close proximity, it may become necessary to resort to extensive resection, it becomes an important matter for the surgeon to know how much of the intestinal tract can be removed without any immediate or remote ill consequences.

The immediate danger attending such an operation is the traumatism, which, of course, will be proportionate to the length of the piece of intestine removed, while the remote consequences are due to impairment of the function of digestion and absorption caused by the shortening of the intestinal canal. With the view of obtaining additional light on these important questions the following experiments were undertaken.

*Experiment 26.*—Dog, weight 22 pounds. Mesentery divided into four portions and tied with catgut, and 30 inches of the ileum from near the ileo-cæcal regions upwards excised and ends sutured together by Czerny-Lambert sutures. Abdominal wound failed to unite, and a copious sero-sanguinolent discharge escaped from it the last day. Death on fifth day from peritonitis. Peritoneal adhesions in abdominal wound only partial: omentum adherent to wound. Intestines firmly adherent to omental stump. Circumscribed gangrene of bowel on convex side at site of operation. Recent diffuse peritonitis caused by perforation.

*Experiment 27.*—In a cat 12 inches were removed from the middle of the ileum, and the ends united by a double row of sutures, mesenteric vessels tied *en masse* with one catgut suture. The animal never rallied from the operation, and died the same night of the shock.

*Experiment 28.*—Dog, weight 36 pounds. Mesentery tied in several sections with catgut ligatures; ileum divided just above the ileo-cæcal valve and six feet of the small intestines excised, and the ends united by Czerny-Lambert sutures. On the third

day the faecal discharges were bloody. Although the appetite remained good, and the dog was allowed to eat as much as he desired, he lost several pounds in weight during the first week. On the third day the abdominal wound opened as the sutures had cut through and required re-suturing. After this time the wound healed kindly. Three or four fluid faecal discharges during 24 hours. The character or the discharges remained the same, and several microscopic examinations made at different times revealed the presence of free undigested fat. The dog was kept busy eating most of the time, and although the most nourishing food was furnished, he emaciated to a skeleton. He was killed 161 days after the operation. Marasmus extreme, hardly a trace of fat could be found anywhere in the tissues. Stomach enlarged to three or four times its normal size, and distended with food. A slight thickening of the wall of the gut indicated externally the site of suturing, and the lumen of the bowel at this point was slightly diminished in size. At point of operation a loop of intestine was found adherent and somewhat contracted. The remaining portions of the small intestines, only 45 inches in length, seemed to have undergone compensatory hypertrophy, as the coats were much thickened and exceedingly vascular. At the seat of suturing the mucous membrane presented a slight circular prominence. Pancreas, liver, and spleen were normal in size and appearance.

*Experiment 29.*—Medium-sized, adult dog. Mesentery tied in several sections, and 8 feet and 2 inches of the small intestines from ileo-cæcal region upwards excised and ends sutured in the usual manner. On the following day the dog vomited, and blood was seen to escape from the abdominal wound. Death three days after operation. The abdominal cavity was filled with fluid and coagulated blood, which on closer inspection was found to have escaped from one of the stumps of the mesentery, where the catgut ligature had slipped off.

*Experiment 30.*—Scotch terrier, weight 10 pounds. Mesentery ligated in parts with catgut ligatures, and the ileum divided 4 inches above the ileo-cæcal region, and 50 inches of the small intestines excised, and the continuity of the intestinal canal restored by the usual method of suturing. Some difficulty was experienced in suturing as the lumen of the upper end was considerably larger than that of the lower. Until four weeks after the operation the dog, although eating well, seemed to become more and more emaciated. After this time he gained somewhat in weight until killed 47 days after the resection. During the whole time the faeces were either fluid or only semi-solid, and at different times contained free, undigested fat. Appetite most of the time

voracious. No adhesions to abdominal wound. Omentum adherent to visceral wound and to bowel. The site of operation is indicated by a slight depression on the surface of the bowel. On palpation a ring-like thickening is felt corresponding to the united ends of the bowel. Bowel above seat of resection somewhat enlarged. On cutting into the bowel the point of union is indicated by a circular prominence of mucous membrane. Nine of the deep sutures were found still attached to the mucous membrane. The entire tract of the small intestines which remains measures only two feet and ten inches in length.

*Experiment 31.*—Adult maltese cat. The mesentery was tied in five sections with catgut ligatures corresponding to 29 inches of the ileum which was excised. Previous experience in circular enterorrhaphy had satisfied me that perforation is most likely to take place on the mesenteric side of the bowel, where on account of the triangular place made by the reflections of the peritoneum the muscular coat is not covered by serous membrane. To obviate this difficulty I secured a continuity of the serous covering of the ends of the bowel before suturing by drawing the peritoneum over this raw surface by a fine catgut suture. The mesentery was detatched only to a sufficient extent to apply the second row of sutures. The fine catgut suture to approximate the edges of the peritoneum must be applied near the margin of the divided end of the bowel, so that the knot will not interfere with the accurate coaptation of the serous surface between the deep and superficial row of sutures. This modification of circular suturing was adopted for the first time in this case. Although the animal manifested no untoward symptoms, and the appetite remained good, the marasmus was progressive until the time of killing, 12 days after the excision. Abdominal wound not completely uniter. Intestinal wound, which was two inches above the ileo-caecal region, completely healed. The sutured surface was adherent to loop of bowel which caused a sharp flexion. Intestine above this point somewhat dilated and partially distended with faecal accumulation. Slight contraction of the lumen of bowel by circular bulging of mucous membrane, in which most of the deep sutures remained fixed. The post-mortem appearance points to partial obstruction at point of flexion; remaining portion of small intestines measures only 21 inches in length.

*Experiment 32.*—Medium sized Maltese cat. Mesentery tied in sections, and 34 inches of the small intestines excised and the divided ends united in the same manner as in the last case, special care being taken to secure an uninterrupted peritoneal surface for divided ends be-

fore suturing. Appetite remained good, but progressive marasmus which appeared at once, continued and proved the direct cause of death 21 days after the excision. Abdominal wound firmly united. No peritonitis. Visceral wound completely united; intestine at site of operation covered with adherent omentum.

#### EXCISION OF COLON.

*Experiment 33.*—Large, black cat. The meso-colon was divided in numerous sections, and each part separately tied with a catgut ligature. As the meso-colon was very short, a number of the ligatures slipped off and had to be replaced by fine silk ligatures. The entire colon and about two inches of the lower end of the ileum were excised. As it was found impossible to unite the bowel on account of the deep location of the rectal end, it became necessary to close the distal or rectal end by inverting its margins and applying a continuous suture. An artificial anus was established by stretching the ileæ or proximal end into the abdominal wound. Death from shock a few hours after the operation.

*Experiment 34.*—Medium-sized dog. Resection of entire colon and three inches of ileum. Meso-colon divided into sections and ligated with silk ligatures. In order to enable circular enterorrhaphy it was found necessary to excise a triangular piece from large distal end, so as to make its lumen correspond to that of the divided ileum. After this was done and the lateral wound closed by two rows of sutures, the ends of the bowel were united in the usual manner. Death from shock six hours after operation.

*Experiment 35.*—Excision of entire colon and two inches of ileum in a cat. Excision of a triangular piece from distal end to narrow the bowel sufficiently, so that its lumen should correspond to that of the ileum. The ileum and rectum were then united by Czerny-Lembert sutures. The animal never rallied from the prolonged operation, and died of shock two hours later.

**REMARKS.**—The results of these experiments speak for themselves. In all cases of extensive resection of the small intestines where the resected portion exceeded one-half of the length of this portion of the intestinal tract, where the animals survived the operation, marasmus followed as a constant result, although the animals consumed large quantities of food. In all of these cases defective digestion and absorption could

be directly attributed to a degree of shortening of the digestive canal incompatible with normal digestion and absorption. Only one of these animals (experiment No. 27) died from shock a few hours after operation. Another death resulted from the trauma in experiment No. 39, where fatal haemorrhage occurred from one of the mesenteric vessels where the catgut ligature became displaced from shrinkage of the included mesenteric tissues. When the vessels of the omentum or mesentery are tied *en masse* there is always danger from this source, and to prevent this accident it becomes necessary not to include too much tissue, and to tie firmly with fine threads of aseptic silk. After I commenced to tie in this manner, I encountered no further difficulty in arresting and preventing haemorrhage in operations requiring incision of these tissues. Although the large artery running parallel with the bowel where the mesentery is attached was excised in every case with the intestine, gangrene and perforation occurred only in experiment No. 26. The post-mortem appearances after extensive enterectomies indicated that the portion of bowel which remains undergoes compensatory hypertrophy, but as a rule the increased functional activity is not adequate to make up for the great anatomical loss. In all instances where the animal recovered from the operation the discharges from the bowels were frequent, fluid or semi-fluid, and contained undigested food, among other substances, free undigested fat, showing that the intestinal secretions play an important role in the digestion of fat. As an approximate estimate the statement can be ventured that in dogs and cats the excision of more than one-third of the length of the small intestines is dangerous to life, as it is followed by marasmus, which sooner or later results in death. As all three cases of excision of the colon proved fatal from shock in from two to six hours, it can be safely asserted that this operation is impracticable, and is invariably followed by death from the immediate results of the trauma.

#### PHYSIOLOGICAL EXCLUSION.

As extensive resections of the intestines are always attended by great risks to life from the trauma, I concluded to study

the subject of sudden déprivation of the system of a great surface for digestion and absorption by eliminating or diminishing the cause of death from this source by leaving the intestine, but excluding permanently a certain portion from participating in the function of digestion and absorption, in other words, by resorting to physiological exclusion. These experiments were also made to determine the tissue changes which would take place in the bowel thus excluded, and to learn if under such circumstances accumulation of intestinal contents would become a source of danger as had been feared by the older surgeons. The complete interruption of passage of intestinal contents either by section and closure of the bowel, or by making an intestinal obstruction of some kind, and the restoration of the continuity of the physiologically active portion of the intestinal canal was established by suturing of the proximal end of the high section with the distal end of the lower section, or by implanting the proximal end into the bowel lower down, the intervening portion of the intestinal tract in either case, thus becoming the excluded portion.

*Experiment 35.*—Large cat, weight 9 lbs. Double division of small intestines, upper section made about eight inches below the pylorus, and the lower three feet lower down; the portion of bowel between these circular sections was closed at both ends, and the continuity of the intestinal canal restored by suturing the open ends in the usual manner. In this way three feet of the small intestines were isolated and completely excluded from the digestive canal. The intervening portion was emptied of its contents as completely as possible before its ends were closed by suturing. The animal died on the fourth day after the operation. A small perforation of the sutured bowel on the mesenteric side was found, otherwise the visceral wound was found well united. The perforation had given rise to diffuse peritonitis which was the immediate cause of death.

*Experiment 36.*—Dog, weight 32 lbs. The jejunum was divided four feet above the ileo-cæcal region, and the distal end closed. Jejuno-colostomy was made by implanting the proximal end into a slit made into the convex side of the ascending colon, large enough to correspond to the circumference of the jejunum. The implanted end was fixed in its position by two rows of sutures. The animal never appeared to rally from the effects of the operation, and died at the end

of the next day. The abdominal cavity was found filled with blood, which must have escaped from a mesenteric vessel from which probably the catgut ligature had slipped. The excluded portion, that is, that portion intervening between the circular section and the point of implantation, was found quite empty of intestinal contents, but slightly distended with gas. Implanted end perfectly retained by sutures and slight adhesions between serous surfaces had already taken place. Death in this case was the result of secondary haemorrhage.

*Experiment 37.*—Dog, weight 35 lbs. Divided the ileum just above the ileo-cæcal region, and closed both ends of the bowel. Ileo-colostomy was done by making an incision about an inch and a half in length on concave side of ileum, 44 inches above the division and a similar slit on convex side of ascending colon, and uniting these wounds by Czerny-Lembert sutures, thus excluding from the intestinal circulation 44 inches of the bowel. The day after operation the feces contained blood. During the progress of the case it is frequently noted that the stools were thin, sometimes liquid. Appetite remained good, and animal was well nourished at the time of killing, twenty-five days after operation. Abdominal wall well united. The omentum and a few intestinal loops adherent to inner surface of wound. The excluded portion contracted to more than one-half of its usual size, atrophic, and not nearly as vascular as remaining portion of intestinal canal, the two blind ends adherent to each other and to adjacent loops. The excluded portion contained in its blind end a few sharp fragments of bone. The new opening between the ileum and colon about the capacity of the lumen of the ileum, surrounded by a prominent margin of mucous membrane, which somewhat resembles the ileo-cæcal valve to which still remain attached about ten of the deep sutures. The coats of both bowels at points of approximation thickened by inflammatory exudation.

*Experiment 38.*—Young cat. The ileum was divided about 30 inches above the ileo-cæcal region; the distal end closed and proximal end laterally implanted into the convex side of the transverse colon, where it was fixed by a double row of sutures. Before implantation the continuity of the peritoneal surface was procured by drawing the peritoneum with a fine catgut suture over the denuded space left after detachment of the mesentery. Although the animal partook freely of food, progressive marasmus set in, to which the cat succumbed eleven days after the operation. Abdominal wound completely healed. Union of implanted ileum with colon perfect. No peritonitis. Excluded portion empty. Bowel above implantation somewhat dilated.

*Experiment 39.*—Young, but full grown cat. Physiological exclusion of two-thirds of the small intestines, and the entire colon by division of the small intestines at the junction of the upper with the middle third. Closure of distal end, and restoration of continuity of the shortened intestinal tract by making a jejunoo-rectostomy. The implantation was made into the upper portion of the rectum at a point opposite the meso-rectum. Previous to section and suturing, the portion of bowel to be excluded was emptied of its contents. Animal died two days after operation. No peritonitis. Slight adhesions between the serous surfaces of rectum and implanted jejunum; excluded portion empty.

*Experiment 40.*—The entire ileum was excluded in a cat by dividing the intestine at its junction with the jejunum, closure of distal end and making a jejunoo-colostomy by implantation of the proximal end into a slit of the transverse colon at a point opposite the meso-colon. The cat remained in good condition until killed 15 days after operation. No vomiting, and movements from bowels normal. Abdominal wound completely closed; no peritonitis; jejunum at point of implantation firmly united; new opening in colon the size of the lumen of the ileum. Excluded portion empty, contracted and anaemic.

*Experiment 41.*—Large mastiff. The small intestine was divided six and a half feet above the ileo-caecal region, the distal end closed, and the proximal end implanted into an incision of the transverse colon large enough to receive it at a point opposite the meso-colon. Suturing was done exclusively with fine silk. For three weeks the dog appeared quite well, ate well, and the discharges from the bowels were normal. From this time the emaciation, which commenced soon after the operation was done, began to increase rapidly, the animal began to refuse food, and died of marasmus 32 days after operation. No peritonitis. Excluded portion empty, and reduced one-half in size; the coats of the bowels very much attenuated, and the vessels hardly half the normal size. Only three feet and five inches of the small intestine remained for physiological action; new opening in colon sufficiently large to permit the introduction of the index finger as far as the first point. On slitting open the colon the point of juncture with the jejunum upon the inner surface is marked by a slight ridge of mucous membrane, which bears a faint resemblance to the ileo-caecal valve.

**REMARKS.**—For some reason which I am unable to explain satisfactorily, in animals where the same length of intestine was

physiologically excluded, as in the resection experiments, the appetite never became so voracious and the remaining portion of intestine did not undergo the same degree of compensatory hypertrophy as in the excision experiments. Theoretically, two explanations might be advanced; firstly, in shortening the intestinal canal by resection an extensive vascular district is cut off by ligation of the mesentery, and it is only reasonable to assume that the circulation in the remaining branches of the mesenteric artery would be increased, and consequently the functional activity of the organs supplied by them augmented; secondly, in cases of physiological exclusion by lateral apposition it is possible that at least some of the fluid contents reached the excluded portion from which a certain amount might still have become absorbed. The exclusion was complete or nearly so, hence, we must conclude from the post-mortem appearances, that in nearly every instance, the excluded portion presented an atrophic, contracted condition and was only sparingly supplied with blood vessels. From a practical standpoint these experiments teach us that a limited portion of the intestinal canal can be permanently excluded from the processes of digestion and absorption in proper cases by operative measures without incurring any risk of faecal accumulation in the excluded part. These experiments demonstrate also that physiological exclusion of a certain portion of the intestinal tract is a less dangerous operation than excision, and that in certain cases of intestinal obstruction, where excision has been heretofore practiced, it can be resorted to as a substitute for this operation in cases where excision is impracticable, or where the pathological conditions which have caused the obstruction do not in themselves constitute an intrinsic source of immediate or remote danger to life. The post-mortem appearances of the specimens of these experiments tend to prove that as long as any of the contents of the intestines reach the excluded portion the peristaltic or anti-peristaltic action in that part is effective in forcing it back into the active current of the intestinal circulation.

## III.—CIRCULAR ENTERORRHAPHY.

During my experimental work I became convinced that circular enterorrhaphy as it is now commonly performed is attended by three great sources of danger: 1, Perforation at the junction not covered with peritoneum; 2, the length of time required in performing the operation; 3, too many sutures.

To obviate the danger of perforation at the junction of the bowel not covered by serous membrane, I resorted to peritoneal suturing before uniting the bowel by drawing the peritoneum over the denuded space caused by the limited detachment of the mesentery by a fine catgut suture applied near the free margin of the bowel as described before. This requires but little time, and secures for the whole circumference of the bowel a peritoneal covering, so that after the bowel has been sutured the great rule inaugurated by Lembert (serosa against serosa) has been carried out to perfection. The results showed that this little modification of the ordinary method of suturing yielded more satisfactory results, and should therefore be adopted in all cases where circular enterorrhaphy is done with Czerny-Lembert or Lembert's sutures. Time plays an important factor in determining the results of all operations requiring abdominal section, and this is especially true in all operations for intestinal obstruction, as this class of patients are usually greatly exhausted before consent for an operation can be obtained. With a patient exhausted from an acute attack of obstruction of the bowels, it becomes exceedingly important to consume as little time as possible in the operation, as the shock incident to a long operation may itself determine a fatal result. Even after I had acquired a fair degree of manual dexterity in suturing the bowel, I seldom spent less than an hour in making a circular enterorrhaphy by a double row of sutures. In opening the abdomen for intestinal obstruction, usually a considerable length of time is spent in finding the obstruction, and when this is found and the patient manifests symptoms of collapse, a radical operation, which for its performance requires an hour or more, is often abandoned and the operation is finished by making an artificial anus, which at

the present time must be looked upon as a reproach upon good surgery. The last objection to the Czerny-Lembert method of suturing requires no argument. Any surgeon who hastily transfixes the bowel with a needle from 30 to 40 times in applying the Lembert suture is liable to perforate the whole thickness of its walls once or more; and if silk is used as suturing material, the puncture may become the seat of a perforation, and the direct cause of a fatal peritonitis. This is more particularly the case in operating on the bowel in cases of intestinal obstruction, as under such circumstances the walls of the bowel have become greatly attenuated from overdistention, and consequently more liable to become perforated by the needle. But the use of so many sutures, from 30 to 40 as recommended, brings with it another source of danger—gangrene of the inverted margin of the bowel. The second row of sutures applied in such close proximity must materially affect the blood supply to the inverted margin of the bowel, which in some instances must terminate in gangrene. Such a result is the more likely to ensue as the inner surface of the bowel is exposed to all dangers incident to infection from the intestinal canal,—in other words, an aseptic condition for one side of the wound cannot be secured, consequently the gangrene is of a septic character, which is prone to extend beyond the primary cause which produced it. To obviate some of these dangers I experimented with a modification of Jobert's invagination suture. According to Madelung the ingenious method of circular suturing devised by Jobert was practiced only in four cases, and two of the patients are known to have recovered. A number of years ago, I was forced to resort to resection of a part of the small intestine in a very complicated case of ovariotomy and resorted to this method, and although the patient died 48 hours after the operation from causes outside of this complication the bowel was found permeable and quite firmly united, and had the patient lived, I have no doubt the result of the resection and suturing would have been satisfactory. In Jobert's method the invagination sutures must be looked upon as a source of danger, as they were made to traverse the entire thickness of the wall of the bowel, and the material used was silk. It has been claimed that in this method the invaginated

portion of the bowel becomes gangrenous as in cases of invagination from pathological causes. This claim has arisen from a theoretical, and not from an experimental standpoint. In cases of invagination the intussusceptum carries with it the mesenteric vessels intact in the form of an arch which by constriction at the neck of the intussusciens is prone to become strangulated, an event which is followed by oedema and inflammatory swelling of the invaginated portion which rapidly tends to complete venous stasis and gangrene. In circular suturing by Jobert's method the intussusceptum has no vascular connection with the intussusciens. The vascular arch is interrupted and consequently the danger arising from venous obstruction is almost completely obviated. My experiments will show that gangrene of the invaginated portion as a rule does not occur. My modification of Jobert's method consists essentially in the use of a thin elastic rubber ring for lining the intussusceptum to prevent ectropium of the mucous membrane, to protect the mucous membrane of the bowel against injurious pressure from the suture, to keep the lumen of the bowel patent during the inflammatory stage, and to assist in maintaining coaptation of the serous surfaces, and finally the substitution of catgut for silk as invagination sutures. My method of proceeding is as follows: The upper end of the bowel which is to become the intussusceptum is lined with a soft pliable rubber ring made of a rubber band, transformed into a ring by fastening the ends together with two catgut sutures. This ring must be the length of the intussusceptum, from one-third to half of an inch, the lower margin is stitched by a continuous catgut suture to the lower end of the bowel which effectually prevents the bulging of the mucous membrane a condition which is always difficult to overcome in circular suturing. After the ring is fastened in its place the end of the bowel presents a tapering appearance which materially facilitates the process of invagination. Two well-prepared fine juniper catgut sutures are threaded each with two needles. The needles are passed from within outwards transfixing the upper portion of the rubber ring and the entire thickness of the wall of the bowel and always equidistant from each other; the first suture being passed in such a manner that each needle is brought out a short dis-

tance from the mesenteric attachment, and the second suture on the opposite convex side of the bowel. During this time an assistant keeps the opposite end of the bowel compressed to contraction and bulging of the mucous membrane. The needles next are passed through the peritoneal, muscular and connective tissue coats at corresponding points about one-third of an inch from the margins of the opposite end of the bowel, and when all the needles have been passed an assistant makes equal traction on the four strings and the operator assists the invagination by turning in the margins of the lower end evenly with a director, and by gently pushing the rubber ring completely into the intussusciens. The invagination accurately made, the two catgut sutures are tied only with sufficient firmness to prevent disinvagination should violent peristalsis follow the operation. This is their only function. The invagination itself effects accurate, almost hermetical sealing of the visceral wound. The intestinal contents pass freely through the lumen of the rubber ring from above, downwards and escape from below is impossible as the free end of the intussusciens secures accurate valvular closure. After a few days the rubber ring becomes detached, and by giving way of the catgut sutures is again transformed into a flat band which readily passes off with the discharges through the bowels. The invagination sutures of catgut are gradually removed by substitution on part of the tissues, hence the punctures in the bowel remain closed either by the catgut or by the products of local tissue-proliferation; and thus extravasation is prevented. In my first experiments I used three invagination sutures, but found by experience that two are just as efficient in making and retaining the invagination. No superficial or peritoneal sutures were used in any of the cases, sole reliance being placed upon the invagination to maintain approximation and coaptation. The mesenteric attachment, both of the intussusceptum and intussusciens was separated only a few lines to enable invagination without too much narrowing of the lumen of the intussusciens.

*Experiment 42.*—Dog, weight 15 pounds. Three invagination sutures were used. The ileum was cut completely across at a point

about three feet above the ileo-cæcal region. Depth of invagination one inch. For two days after operation a slight rise in temperature; no symptoms of obstruction during the whole time. Animal in good condition when killed two weeks after operation. Omentum adherent at point of operation as well as to adjacent loop of intestine. Union between intussusceptum and intussuscipiens firm, no signs of gangrene. Narrowest portion of lumen of bowel was large enough to pass the little finger to second joint. An enterolith composed of fragments of wood, bone, etc., in the centre of which the straight rubber band which had been the rubber ring, was found just above the seat of operation. No distention of the bowel above this point. Bowel considerably flexed at seat of invagination, this condition being evidently brought about by inflammatory adhesions.

*Experiment 43.*—Dog, weight 20 pounds. Section of bowel and invagination with rubber ring the same as in the foregoing experiment. In subsequent history no mention is made of any symptom of obstruction, but for the last few weeks it was noticed that the dog began to emaciate. He died suddenly 81 days after the operation. Diarrhoea was a prominent symptom toward the last. No adhesions and no peritonitis. An enormous enterolith composed of all kinds of crude material, and again holding to its centre the rubber band, was found just above the invagination. Bowel at this place considerably dilated. Intussusceptum firmly adherent, a false passage admitting the tip of the little finger had been made on one side between it and the intussuscipiens. Death in this case was evidently produced by the enterolith. In this, as in the last case, the invagination was made at least an inch in length, and the collection of the crude, indigestible material, which the dog must have eaten in large quantities, around the detached rubber ring gave rise to the enterolith. The wall of the bowel surrounding the foreign body was not only dilated, but also greatly thickened. It is a well known fact that even a moderate degree of stenosis of the bowel in dogs is liable to give rise to the formation of an enterolith, as the crude material which these animals swallow becomes arrested and by constant accretions of the same kind of material, the enterolith forms and continues to increase in size until its presence causes catarrhal inflammation and finally intestinal obstruction.

It is quite possible that the lower end of the intussusceptum in the last case became impermeable during the inflammatory stage, and that the false passage was formed on this account by perforation on one side of the intussusceptum, an accident which was plainly traceable to too deep invagination.

*Experiment 44.*—Dog, weight 40 pounds. This experiment is interesting only from the fact that it shows that it is possible to make a mistake in the direction of the invagination, even after the operation has determined with accuracy which is the ascending and descending end of the gut, and to show the disastrous consequences which must necessarily follow such a technical mistake. The invagination was made in the usual manner with rubber ring and three catgut sutures. The animal appeared to be quite ill the day following the operation, and on the next day the thermometer showed a rise in temperature to 104.2°F. On the third day the dog died with well marked symptoms of perforative peritonitis. Recent peritonitis with some agglutinations of intestines. Considerable quantity of sero sanguinolent fluid in the peritoneal cavity. To my utter astonishment, I found that an ascending invagination had been made. Circular gangrene of intussusceptum and complete separation of ends was found. The rubber ring remained *in situ* still attached to the intussusciens by the catgut sutures, which had become somewhat softened. The invagination had decreased considerably by the traction caused by the peristalsis and by the pressure of the intestinal contents from above the obstruction, and the extensive gangrene of the bowel was undoubtedly determined to a great extent by these causes.

*Experiment 45.*—As an illustration of another source of danger due to faulty technique, I will relate this experiment. Medium-sized dog. Circular enterorrhaphy was done with the rubber ring two feet above the ileo-cæcal valve. In making the invagination it was noticed that the ring was too large, as it was seen that it caused too much pressure. Thinking that the parts might adapt themselves to this pressure, the bowel was replaced and the abdominal wound closed. The dog died 36 hours after the operation. Abdominal wound not united; omentum and intestines adherent to each other, and at point of operation. The circumscribed gangrene of the intussusciens was evidently entirely due to pressure on part of the rubber ring. The intussusciens was much swollen, a condition which materially aggravated the pressure caused by the rubber ring. With the following experiment two new departures were inaugurated, viz.: Instead of three invagination sutures only two were used, a change which still further shortened the time for performing the operation, and the use of Nothnagel's test in determining the direction in which the invagination should be done. In all of the remaining experiments of circular enterorrhaphy which were made only two catgut sutures were used. Until now it was always necessary to find one of the extremi-

ties of the small intestines for the purpose of determining which was the afferent and which was efferent end of the tube, so as to make the invagination in the right direction, a procedure which often required considerable time, and brought additional risk by increasing the shock of the operation and the danger of traumatic infection.

[TO BE CONTINUED].

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### ERASION OF THE KNEE JOINT.

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THE operation known as erosion or arthrectomy of the knee joint, can scarcely yet be said to have attained its full significance, or become so developed and perfected as to claim the title of an universally recognized and adopted surgical procedure. It is true that many operators have performed it, yet the published accounts of their methods, and especially of the ultimate results obtained, are by no means numerous in comparison with the number of cases in which the operation seems to have been adopted. Hopes may be entertained, however, that this will be altered, and the next few years find the literature of this operation more explicit, and the methods of its performance more generally and better understood. I do not propose to enter into the question of priority of invention of this operation. Such matters are difficult to solve with justice, and the study is an unprofitable one. We may readily understand how the necessity for operations of this kind has gradually arisen. The result of formal excisions of the knee were not such as to satisfy individual operators. A large number of excisions were undertaken for cases of synovial disease where the bones, if at all implicated, were quite superficially affected. The removal of slices of bone and impairment of proper growth which ensued in consequence seemed unsatisfactory. Soon less extensive operations began to be devised. Most of these seemed to err on the side of insufficient removal